Processing, Bagging and Autoclaving Dental Instruments: A Guide for Dental Assistants

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Abstract

This article presents a general clinical approach for the processing of dental instruments for sterilization in the autoclave, with an emphasis on using sterilization bags to package loose instruments, versus the use of wrapped instrument cassettes. This article provides dentists and dental assistants with techniques of cleaning instruments, such as using ultra-sonic instruments, removing rust from instruments, or a cleaning instruments with a wire brush, prior to autoclaving instruments. A review of sterilization parameters and general information about how to use and maintain an autoclave are presented. A discussion of how to prepare burs and endodontic hand instruments for autoclaving is also presented. The article discusses if an instrument should be bagged individually, or if it should be bagged as part of a set of instruments. The sorting of bagged and sterilized, versus bagged and unsterilized instruments, is also discussed, as is the concept of instrument redundancy to prevent sterilization bottlenecks. In dentistry, the gross removal of debris from instruments prior to placing in an autoclave pouch for autoclaving reduces the overall bio-burden on the instruments and facilitates proper sterilization of instruments.

Keywords: Sterilization. Dentistry. Dental Instruments.

How to cite this article:
Mamoun J. Processing, Bagging and Autoclaving Dental Instruments: A Guide for Dental Assistants. Monographs in Dental Assisting. May, 2016.

Introduction

An autoclave sterilizes instruments or other items by exposing instruments to a combination of high heat and pressure. An autoclave heats pure distilled water placed inside the autoclave to generate pressurized steam that flows around instruments that are bagged inside specialized sterilizable autoclave bags or pouches. These bags can be all paper or, more practically, can have a paper side and a see-through plastic side that allows the dentist to see the contents inside the bag. Pressurized, heated steam penetrates through the paper side of the bag and inside the bag to sterilize the instruments. Two common sterilization parameters of an autoclave include 121° C / 250° F with a pressure of 103 kPa / 15 psi for 30 minutes, or 134° C / 273° F with 206 kPa / 30 psi of pressure for 15 minutes. Exposing instruments to pressurized steam at these parameters sterilizes pathogens on the instruments, such as viruses and bacteria, and hardier organisms such as bacterial spores and prions[1,2]

Autoclaving is probably the most systematic way of sterilizing dental instruments, and sterilizes the broadest range of organisms compared to other forms of sterilization.[3] Cold sterilization does not sterilize as wide a range of organisms as does steam autoclaving,[4,5,6] and cold sterilization chemicals can evaporate into the office and create an uncomfortable odor. Dry heat sterilization takes more time to effect sterilization,[7] may be less effective against bacterial spores,[8] may require non-see-through all-paper bags, and may excessively heat handpieces.

An autoclave has a water well, which must be filled with distilled water. The well must not be filled with tap water, which contains dissolved minerals that can corrode the autoclave. A dial or button is used to make distilled water move from the well to the inside of the autoclave, to fill the autoclave chamber with a certain minimum volume of distilled water, to a fill line level that is indicated inside the autoclave. The assistant must check the well from time to time to make sure it is filled with enough distilled water to fill the autoclave chamber. An incompletely filled autoclave may overheat and start to smoke during an autoclave cycle. Distilled water can be bought in gallon jugs and brought to the office, which can be tedious to do on a frequent basis. Distilled water can also be produced on-site in the office using an water distilling appliance.

The autoclave also has a timer mechanism, to ensure that, in an autoclave cycle, there is enough time for the autoclave to heat up to the proper temperature and pressure parameters to effect sterilization and, in addition to that time, to expose the instruments to these parameters for as much time as is needed to sterilize the instruments. An autoclave starting from a cold start may require 50-60 minutes to sterilize the instruments. However, less time is required to sterilize instruments if the autoclave has been heated up from a previous cycle. The autoclave also has a venting button to vent the pressure after the cycle is completed, since the autoclave door can only be opened once the pressure has decreased. Modern autoclaves may be completely computerized automated machines, that automatically run the autoclave cycle after pressing a button to start the cycle. Bagged instruments tend to be very hot and moist upon removal from the autoclave, although some autoclaves have a drying cycle that dries the instruments prior to their removal from the autoclave.

General Principles of Bagging Dental Instruments

The workhorse dental sterilization bag is the 3.5"x10" inch bag. Generally, the larger the autoclave bag, the more expensive it is. A 5.5"x11" sterilization bag is twice as expensive as a 3.5"x10" bag. Therefore, as a general rule, the assistant should use the smallest size bag that can bag an instrument or a set of instruments. Saving a few cents per procedure this way can add up to significant savings over the year. The 3.5"x10" bag, with the 5.5"x11" bag, can bag nearly all typical single instruments, or instrument sets. A 3-piece XCP or Rinn x-ray positioning device needs a 5.5"x11" bag, as does bundling a basic setup with the other instruments needed for a procedure together in the same bag. Generally, a rongeur (a type of narrow-beaked oral surgery plier) may not fit in a 3.5"x10" bag, and the handle of it may rip out of the bag, but fits in a 5.5"x11" bag. Instrument cassettes need larger, more expensive bags, since cassettes tend to have wide width and a height of 1-3 inches.

There are several "styles" by which a dental office may bag instruments. Some offices bag syringes separately, and basic setups separately, and bag bunches of instruments required for a particularly procedure separately (such as all of the instruments for a restorative procedure separately). Here, after seating a patient, a dentist removes a basic setup from a bag, looks inside the patient's mouth to see what specific procedure needs to be done, then removes a syringe from a bag to anesthetize the patient, then instructs the assistant to obtain a bag that contains the instruments fro that specific procedure. Here, the basic setup is not bagged with the other specific instruments needed for the procedure.

Alternatively, an office may bag syringes separately, but bag all of the instruments needed for specific procedures, in addition to the basic setup, all in one bag. The dentist would have to open up a large bag of

instruments to obtain a basic setup, but this can be efficient if the office knows before seating the patient what procedure will be done on the patient.

An office could also combine these styles, by both bagging syringes and basic setups separately, and also having some large procedure bags containing the specific instruments needed for a procedure combined with a basic setup in the same bag (**Fig. 1**). This is perhaps most flexible for the dentist logistically.

Fig. 1: Example of a basic setup bagged separately in a 3.5"x10" bag (left), versus the basic setup bundled in a 5.5"x11" bag with the other instruments of an amalgam restorative dentistry setup (right).

An office might also not separately bag sets of basic setups, but instead bag bunches of each individual instrument in a large autoclave bag. For example, 20 mirrors might be bagged in one big bag, 20 explorers in another, and 20 college pliers in another bag. These big bags would be placed in the operatory and opened, and the dentist or the assistant would grab an instrument from the bag as needed. This approach, which may save an office time and money from needing to use fewer bags to autoclave instruments, is potentially unsanitary and is not recommended, since dust, fingerprints and saliva could contaminate instruments inside the bags.

Some plastic instruments or parts are autoclavable, and some are not. If unsure, an assistant should ask the dentist if a plastic part is autoclavable. Some plastic parts are labelled whether or not they are autoclavable. If a plastic part or instrument warps or melts after being autoclaved, then it was not designed to be autoclaved, and the assistant should not autoclave another example of that part or instrument again. Occasionally, however, an autoclave may malfunction and overheat beyond the maximum 273° F temperature, and melt plastic instruments that normally would survive autoclaving. Some plastic parts may crack from fatigue after numerous autoclave cycles.

Burs can be bagged by putting a bunch of them in a bag, or by arranging them in a sterilizable bur container called a bur block (**Fig. 2**). A bur block should ideally have holes for high speed (friction grip) burs, which are small in diameter, and low-speed (latch or contra-angle) burs, which are slightly larger in diameter.

Fig. 2: Instruments that are often bagged individually include (clockwise from top left) a cement spatula, an oral surgery elevator, scissors (opened up to expose blades to steam), a slow-speed contra-angle handpiece (bagged in two separate parts), a high-speed handpiece, a syringe, a bur block and a hemostat (open in the bag).

Peeso reamers and Gates Gliddens burs, used for endodontics, can be bagged freely inside an autoclave bag or placed in a metal endodontic box with holes to contain endodontic instruments. Gates Gliddens burs or Peeso

reamers should not be put in a bur block, since these burs are tall, and will likely be bent when the bur block is closed. A bent peeso reamer usually needs to be discarded in the sharps container. An assistant can determine if a Peeso reamer or Gates Glidden bur is bent by turning the bur between the finger tips and seeing if the tip turns concentrically, which would show that the bur is straight.

Scissors and hemostats should not be autoclaved while closed, since this prevents steam from penetrating their tips. Instead, scissors and hemostats should be be opened up all the way, and should be able to fit this way into a 3.5"x10" bag (**Fig. 2**). Oral surgery forces are too bulky to be placed in open position in a bag, but when closed their tips are usually slightly separated.

Rust and Dental Instruments

"Surgical milk" is a milky-white solution of a rust inhibitor and lubricator mixed with distilled water. Instruments are soaked in this solution for 30-60 seconds to allow the solution to penetrate the instruments, then the instruments are patted dry of excess solution (without rinsing off the solution), bagged in the sterilization bag, then autoclaved. Surgical milk inhibits rust during the autoclaving process, and lubricates instruments, which prevents hinged instruments like oral surgery forceps from squeaking during use. Surgical milk can come in a pre-mixed solution, ready for use, or may have to be mixed with a certain proportion of distilled water.

Autoclaving instruments that are made of dissimilar metal alloys and are put in the same bag can sometimes result in rust of the instruments. Burs that are manufactured by soldering the cutting tip of the bur to the shank of the bur may develop rust at that solder junction after autoclaving. One-piece burs, which are more expensive, do not have a solder junction that can rust. Burs and endodontic files will not rust if sterilized in a dry heat sterilizer, but such sterilization may require 2 hours at 390° F to effect sterilization, and dry heat sterilizers may not be compatible with partly plastic autoclave bags, but may require all-paper (non-see-through) autoclave bags. Some metal alloys in instruments are more rust-prone than others. Some instruments are labelled as stainless steel, but may actually be made of a lesser quality steel that may rust.

Rust can be removed by soaking instruments in rust-removing solutions, sometimes for hours. If the rust cannot be completely removed, the instrument may need to be discarded, since the instrument may appear unsanitary to a patient. A very fine #0000 grade steel wool can be used to scrape away rust from instruments without visibly scratching the instruments, although such scouring may remove a microscopic surface layer of metal from the instrument.

Spore-Testing of the Autoclave

Autoclaves need to be tested periodically, typically once per week,[7] to ensure that they are functioning. A spore test, or a small envelope with a live bacterial sample or spore in it, is placed in the autoclave to ensure that the autoclave cycle will kill the spores and bacteria, and this test strip is then mailed to a testing facility. The facility will return a report of the results. Some spore testing companies provide a pre-addressed mail-back envelope. The assistant autoclaves the sample, seals the sample in the envelope and mails the envelope (**Fig. 3**).

Discarding or Re-using Instruments and Burs

Anesthetic needles or irrigation needles generally cannot be sterilized to successfully destroy pathogens such as the viruses that cause AIDS, Hepatitis or Herpes. Instead, needles should be used only once and then disposed in the sharps container. Syringe tips can be screwed off the syringe with gloved fingers. However, for safety reasons, an assistant should never attempt to remove a needle from a syringe unless the needle is capped.[9]

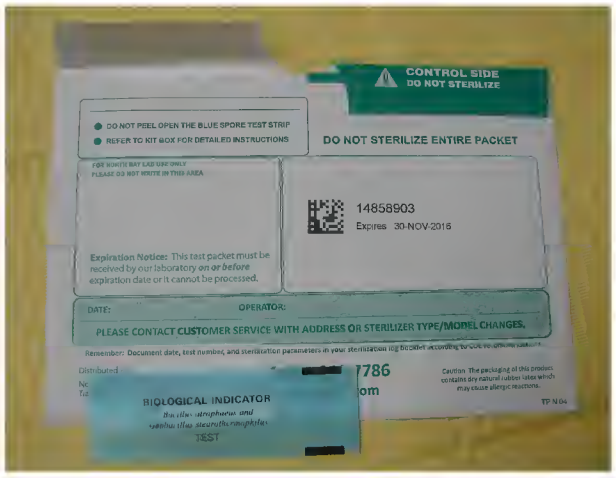

Fig. 3: An autoclave bacteria and spore test packet (lower left blue glassine strip), shown with an envelope that the packet is placed into for mailing to the sterilization monitoring laboratory.

The syringe tip may be grabbed with gloved fingers at the hub to unscrew it, but not from the top of the cap, which result in the cap slipping off. Also, the palm of the hand should be positioned to the side of the needle; while unscrewing the needle, the hand should not be positioned such that the palm is touching the tip of the needle cap, since if the cap slips the needle may injure the palm. If the needle hub is made of plastic, the needle can sometimes be removed by grabbing the needle from the hub using pliers and "bending" the hub off the screw end of the syringe, then while still grabbing the needle with the pliers, dropping the needle (and the empty glass anesthetic cartridge) in the sharps container. An assistant should be careful not to inadvertently autoclave a syringe with a used cartridge still inside the cartridge bay.

Heavily encrusted or rusty burs should be discarded in the sharps container, since debris on the bur may prevent pressurized steam from penetrating to the metal of the bur to sterilize the metal. Burs encrusted with blood or debris are most easily cleaned as soon as the dentist is done using the burs, before the material has hardened or dried on the bur. Soon after the procedure is finished, the assistant may be able to remove debris from burs by quickly and efficiently wiping the burs with an alcohol-soaked gauze pad, while being careful not to get stuck by the bur. Cleaning burs with a washer-disinfectant machine prior to autoclaving can help ensure bur sterilization.[10,11] A dentist might only use a surgical bur once before discarding it, due to the risks of cleaning sharp, bloody burs used in an extraction, and since it will be less efficient to surgically cut a tooth using the same, re-sterilized bur, that will not be as sharp as a new one. Powdery debris on a round bur or fissure bur can be cleaned using a wire brush or cleaning out each flute one-by-one using an explorer tip.

The assistant should ask the dentist when the dentist feels that burs or endodontic files should be discarded instead of being re-sterilized. Burs and endodontic hand files that are too tightly encrusted to efficiently clean should be discarded. Endodontic hand files that are excessively distorted, or that show bald spots on the corrugated file surface, should be discarded. Some dentist feel that endodontic files or burs should not be re-sterilized because it is difficult to guarantee their sterility resulting from an autoclave cycle.[12] Heavily worn burs or endodontic files, or diamond burs with worn cutting tips, should be discarded, although the dentist would know more than the assistant which burs or files are excessively worn. It is sometimes prudent to discard surgical length carbide burs after the first usage during a tooth extraction, and particularly after the second or third usage. Expensive disposable items like rotary endodontic files should probably not be discarded without the dentist's authorization. Burs and endodontic files should be discarded in the sharps container, and not the regular trash.

Matrix bands generally become damaged during their first use and are best thrown in the sharps container rather than sterilized. Scalpel blades may rust from the autoclave cycle, and are perhaps much less useful once their edges have been slightly dulled from their first usage, so they too might be thrown out into the sharps container instead of being re-sterilized. The

handle of a scalpel blade, to which the blade is attached, is always re-used and sterilized. A plastic handle scalpel with a blade attached is disposable and should be discarded after the first use, since autoclaving will likely melt the plastic scalpel handle. Dappen dishes made of silicone are autoclavable, as are bite blocks made of rubber or silicone.

Autoclave Maintenance

An autoclave may develop a thin encrustation of minerals or rust inside the chamber, often concentrated at the bottom of the chamber which tends to be the hottest part of the chamber. This is because sometimes even distilled water may have trace amounts of minerals or impurities in it that eventually encrust inside the autoclave. This mineral layer can function like an insulator, preventing the metal lining of the chamber from conducting heat optimally to the inside of the chamber, and may cause the autoclave to need more time to heat up, may reduce the maximum average temperature of the autoclave, and may reduce the amount of time when the autoclave is at an optimal temperature and pressure for sterilizing instruments. This mineral layer can be removed using special autoclave cleaning powders or solutions. The mineral layer can be reduced slightly by rubbing it with a moist paper towel to pick up small amounts of debris. Scouring the autoclave chamber to remove the mineral layer, such as with steel wool, may scratch and wear away the metal of the chamber and is not advised.

If an autoclave is leaking water or pressurized steam from the autoclave door, or is taking more time to pressurize or heat up, the dentist may need to replace the autoclave gasket. This is a silicone ring that is put around the inside of the autoclave door to help seal the door to prevent such leakage (**Fig. 4**). Sometimes, as a stop-gap measure, the assistant may stretch out the gasket to expand its diameter slightly, so that it fits with more snugness into the autoclave door. There should be backups of the gasket at all times in the office.

Fig. 4: This autoclave has been loaded with bagged unsterilized instruments separated with two shelves. The red ring inside the door is a silicone gasket that helps seal the autoclave door, preventing water or pressure leakage.

Separating Sterilized Bags from Unsterilized Bags

The assistant should know the difference between a sterilized bag and a non-sterilized bag. On the bags there is an indicator that changes color when the bag is steam sterilized. The assistant must be careful not to place inadvertently non-sterilized bagged instruments as part of a dentist's setup in the operatory. However, the dentist should be alert enough to double check that all bagged instruments he or she is given in the operatory are sterilized, and detect any non-sterilized bagged instruments before opening the bag and using the instrument in the operatory.[13]

The location on a tabletop where instruments are processed can become contaminated from the contaminated instruments. The assistant should not place sterilized bagged instruments, that have just been removed from the autoclave, on this contaminated surface. Instead, sterilized bagged instruments should be moved directly from the autoclave to designated clean areas or drawers for storage, as soon as the sterilized bagged instruments are removed from the autoclave (**Fig. 5**).

Fig. 5: Sterilized autoclaved bags should be stored plastic-side up in a flat drawer, such that instruments are instantly visible through the plastic, and not bunched together, which would prevent easy location of an instrument.

Some assistants temporarily place sterilized bagged instruments on top of the autoclave, paper-side-up, to give them time to dry, then after drying place them in their designated storage areas in the office. If this is done often in an office, then the office should as a policy designate the top of the autoclave as a clean surface and never place unsterilized or bagged but unsterilized instruments on top of the autoclave. However, if an instrument is still hot when placed in its designated storage area, paper-side-up, the heat in the instrument will usually make all of the moisture in the bag evaporate through the paper, without needing to temporarily store the instrument on top of the autoclave to dry.

It is easy to accidentally mix bags of sterilized instruments with bags of unsterilized instruments. It can be tedious to observe the sterilization indicators of each individual bag to determine which bags are sterilized and which are unsterilized. If two piles, one of bagged sterilized and one of bagged unsterilized instruments, are put on a flat surface close to one another, the piles of bagged instruments may flow and move randomly, and eventually mix together. To prevent this, a designated basket, about 1-2 cubic feet in volume, should be placed next to the autoclave in which to temporarily store bagged but unsterilized instruments, prior to their placement in the autoclave (**Fig. 6**).

Bagged sterilized instruments may be stored in a basket that is designated specifically for storing bagged sterilized instruments. Bagged sterilized instruments may also be placed directly in designated storage shelves or drawers within the office as soon as they are removed from the autoclave. Bagged sterilized instrument may also be placed temporarily on top of the autoclave to dry, before they are put into their designated storage areas. All bagged instruments should be stored in designated locations at all times, and not placed randomly on a non-designated surface in the office.

The author suggests the office has many labelled 2.0 inch high drawers for storing bagged sterilized instruments face-up for easy locating, instead of bunching bagged instruments in a big drawer, making them hard to find (**Fig. 5**). Some offices store bagged

Fig. 6: An autoclave is on and sterilizing instruments, while a small plastic basket with bagged but unsterilized instruments is next to the autoclave. The top left gauge above the door shows the pressure, while the top right gauge above the door shows the temperature.

sterilized instruments in trays that combine the bagged autoclaved instruments, that are needed for a particular procedure, with the disposables that are needed for that procedure. These trays are stacked in a rack designed specifically to store these trays. When the dentist needs to perform a specific procedure, the assistant simply grabs the pre-made tray and takes it to the operatory.

Preventing Sterilization Bottlenecks

Having multiple backups of frequently used instruments prevents lost chair-time due to sterilization bottlenecks. These bottlenecks are caused by not having a sterilized copy of an instrument when it is needed for a patient visit.[14] A dental office may need to perform the same procedure, or use the same type of instrument, on multiple patient visits in a row. Syringes and basic sets, for example, may be needed for 5-10 patient visits in a row depending on the office schedule. The office will need enough sterilized copies of frequently used instruments to be able, if the schedule requires it, to use the same type of instrument for multiple patient visits in a row, without being under severe time pressure to sterilize the copies of that type of instrument that was used. After using sterilized copies of the same type of instrument multiple times in a row, there should still be enough sterilized copies of the same instrument left to perform the same procedure again several times in a row, to give the assistants enough time to perform a complete autoclave cycle to sterilize those copies of the instruments there were previously used. As a general suggestion, it may take 1 hour to pile up enough instruments to fill up the autoclave for a cycle, plus 15 minutes to bag those instruments for the autoclave, and 1 hour to autoclave the instruments, and 15 minutes to cool off the sterilized instruments. Based on this suggestion, there should be enough sterilized copies of frequently used instruments to perform the same procedure that these instruments allow the dentist to perform, for 2.5 hours straight. If a dentist can perform 7 restorative procedures in 2.5 hours, then at least 7 sets of instruments for restorative procedures are required. If the dentist sometimes uses 12 syringes or basic sets in 2.5 hours, then the office should have at least 12 sterilized syringes or basic sets sterilized at the start of the workday.

Also, some mission-critical instruments like handpieces can break or jam up more easily, and so a dentist would ideally have 10-15 copies of these instruments on hand. Sometimes multiple copies of the same instrument can fail during the day, risking panic if there are not enough backups of backups. Frequently used instruments require backups of backups, such as XCPs or bur blocks or basic setups or syringes. For infrequently used instruments, there is less need for backups, but having 3-4 sterilized copies of infrequently used instruments is probably beneficial as well. If the office brings in an associate, sterilized instruments will be consumed at a more rapid rate, increasing the need for instrument redundancy.

The assistant should never interrupt an autoclave cycle before the cycle finishes, even if it contains a critical instrument that is needed immediately for patient care. If, during the office workdays, a specific instrument is frequently unavailable because it is in the autoclave, this informs the dentist to order more copies of that kind of instrument to prevent such bottlenecks in the future.

Bagging Individual Instruments versus Sets of Instruments

A dentist could take photographs of which sets of instruments are used for each different procedure used in that office (such as the set of instruments for the basic sets for the initial patient examination (mirror, explorer, college pliers and metal air/water syringe tip), the set of instruments for performing amalgam or composite restorations, or the instruments for endodontic procedures, or crown and bridge preparation or insertion visits, etc.). The dentist could then print out these photos and pin them on the wall of the sterilization room as a reminder of which instruments belong in which

setups. When an assistant is in doubt whether to bag an instrument individually or in a set, the assistant should ask a co-worker or the dentist for advice, or, if help is not available at that moment, to bag the instrument separately.

Some instruments are usually bagged individually, one per bag. Examples include oral surgery forceps, elevators, cement spatulas, the set of three pieces of the XCP setup, rubber dam forceps, hemostats, bur blocks, handpieces, a composite applicator gun, cavitron tips (whether magneto restrictive or turbo-piezo tips), flexible silicone mixing cups, bite blocks, alginate spatulas, buffalo knives, endodontic files bundled in a metal file box, and anesthetic syringes (**Fig. 2**). Some dentists prefer periodontal probes to be packaged separately.

In general, very sharp instruments should not be put in a set of instruments in a bag, but should be bagged separately (**Fig. 2**). It is difficult to spot a sharp instrument in a bag of relatively non-sharp instruments, so the dentist or assistant could be cut when opening the bag. Also, if the bag is moved abruptly, the other instruments may move with enough force to push the sharp instrument through the bag, which can result in a sharps injury, or compromise the sterility of the bag. For example, a scalpel, an endodontic explorer, or scissors should be bagged separately. Some dentist prefer to bag dental hygiene scalers separately.

Handpieces and Autoclaving

High speed handpieces are bagged individually in 3.5"x10" autoclave bags. If a high-speed handpiece is requires a bur-changing chuck, the chuck can be put in the same bag as the handpiece. This saves the cost of a separate bag for the chuck, and saves the time needed to search for the chuck in the autoclave. A push button high-speed handpiece does not require a bur-changing chuck. For slow speed handpieces that consist of two parts, each part can be bagged in a separate bag, or two parts can be put in the same bag, but the assistant should not connect the parts together in the bag but leave them separate in the bag (**Fig. 2**).

Handpieces should be lubricated before sterilization, by putting handpiece lubricant in the small hole of at the part of the 4-hole handpiece that attaches to the dental chairside unit (**Fig. 7**). A spray-on mini-straw can be used to spray pressurized handpiece cleaner inside the handpiece to clean debris from the tip of the handpiece and the turbine inside the handpiece head, although this vaporized material contains solvents and should not be breathed in.

Fig. 7: Lubricating a hand-piece with a few drops of hand-piece lubrication oil placed in the small hole at the end of the hand-piece.

There are also automatic handpiece cleaning machines where the handpiece is attached inside the machine and a button is pressed to automatically clean and lubricate the handpiece. The head and neck of the handpiece should be inspected for blood or debris and carefully cleaned with an alcohol wipe prior to autoclaving. Handpieces last longer if they are lubricated just before use on a patient, after unwrapping the handpiece from the sterilized bag in the operatory.

If a handpiece turbine stops working while the dentist is using it, the assistant may need to

change the turbine. A handpiece turbine may also fall apart while the dentist is using the handpiece. The assistant may then receive a handpiece from the dentist with parts missing like the turbine cap or with a jammed up turbine taken out of the handpiece. The assistant should know how to replace the handpiece turbine. Pliars are used to remove the cap, then the turbine is removed from the head of the handpiece, and a new turbine placed in, by aligning a tiny circular bubble protruding from the top of the turbine with a concavity, corresponding to that bubble, in the top part of the turbine chamber of the handpiece. If the bubble on the turbine is too big to fit in the concavity inside the handpiece head, a dentist could drill on the bubble to trim it slightly until the turbine fits. After placing the turbine, the cap is placed back on, by first hand-tightening the cap to ensure that the tiny cap screw threads are aligned with the tiny handpiece head screw threads, and then using pliars for a final tightening. The assistant should be careful not tighten the cap too much, since the screw threads are small.

Cleaning Debris off Instruments

If instruments are encrusted with debris, the debris could prevent pressurized steam from penetrating to the surface of the instrument, resulting in a small volume of unsterilized material on the instrument. The less debris or the fewer micro-organisms there are present on an instrument before it is bagged and placed in the autoclave, the greater the probability that the autoclave will completely sterilize the instrument. Dried debris on endodontic files or burs can be removed by scraping the file between the serrated tip of a college pliars, although this could scratch and weaken the file, limiting further use of the file. Alcohol-soaked gauze can efficiently wipe away non-dried debris from endodontic files or burs. A wire brush can be used to clean away debris, holding it using strong utility gloves for protection from sharps injuries.

Instruments with debris on them can be scrubbed with a soft brush in sink, or while immersed completely in water containing a detergent that is acceptable for use with surgical instruments. Scrubbing instruments under water prevents splashing of water, which could occur if scrubbing instruments under running tap water. If not all instruments in a setup have been used, such that only a few instruments have debris, the assistant can focus on cleaning just those instruments with debris. If a detergent solution is used to clean instruments, water must be used to completely wash away any detergent. Tap water can be used initially, because it is inexpensive, but the final rinse must be with distilled water. Do not use saline solutions, or sodium hypochlorite, to soak or to clean dental instruments. These solutions can cause corrosion of the instruments, before or during autoclaving.

Ultra-sonic cleaners use a solution of distilled water and a specialized medical instrument detergent to clean microscopic amounts of debris from instruments, that may not be cleanable using hand scrubbing or rubbing the instrument with alcohol-soaked gauze.[15] Instruments should be placed in a basket made for the ultra-sonic unit, and not directly on the floor of the ultra-sonic chamber, which may result in the instruments scratching the ultra-sonic unit floor. Use only a specially designed ultra-sonic instrument solution to clean the instruments, not a household cleaner. Some solutions are designed to clean hard things like cement from instruments, while others are more appropriate for general removal of softer debris like caked on blood. Handpieces should not be cleaned in ultra-sonic cleaners.[16]

Instrument washers can also be used to clean instruments in an automated way, according to the directions of the instrument washer machine. These machines are expensive and are perhaps best used along with a system of cassettes for holding instruments. These cassettes can be expensive to bag due to the larger, more expensive bags that are needed to contain the cassettes, or due to the time and expense of wrapping the cassettes for use in the autoclave.

XCPs and bite blocks should be rinsed with water until protein and saliva is washed off from them, prior to placing them in the autoclave. Autoclaving them with these proteins will cause the proteins to become caked on and sealed into the instrument. and the patient may taste these sterilized proteins later. Dental mirrors should be spotless before bagging, since a cloudy instrument is noticeable to a patient and may appear dirty to the patient.

Instruments that have fresh blood on them after a procedure, such as periodontal hand scalers or oral surgery instruments, can be easily cleaned by placing the tip of the instrument in the inlet of a high volume suction tube under a tap water spout, so that water is sucked into the inlet and flows rapidly and forcefully over the tip, washing away the blood (**Fig. 8**).

Fig. 8: Cleaning fresh blood off an oral surgery elevator, by placing the elevator tip inside an HVE suction inlet while tap water is sucked into the inlet over the elevator tip.

Removing dried blood is difficult, especially if the blood gets into corrugated instrument surfaces like the tiny teeth of a college plairs or an extraction foreps with tiny serrations in its tip. Water cleans fresh blood off a bit more easily than does an alcohol swab, although an alcohol swab may more efficiently clean off dried blood than use of water. A handpiece with a bloody bur attached to it may also be cleaned of blood in this manner, which may be safer than handling the bur directly with fingers. This is a convenient and fast way of cleaning bloody handpieces and surgical burs after a surgical extraction, although some dentists may as policy discard all surgical burs after the first use. Debris that is encrusted into the grooves of burs like round burs may need to be scraped off using an explorer tip to clean out each groove individually.

Glass ionomer is a common type of cement used in a dental office. Soon after it has been mixed, while it is still moist, it can easily be washed away from instruments using tap water. However, it can harden up rapidly and may need to be scraped off or removed in an ultra-sonic cleaner (with a cement removal solution) if it hardens on an instrument. The assistant should wipe off or wash off with water unset glass ionomer cement as soon as the dentist has finished using the instrument or glass mixing pad. Mixing the cement on a disposable wax paper surface can prevent the difficulty of cleaning set cement from a glass slab.

In general, any time a cement is mixed, the assistant should quickly wipe away cement from any instruments before the cement is set. Wet gauze can easily be used to wipe away fresh glass ionomer or carboxylate cement. A cement spatula or the flat end of a college pliars can be used to scrape hardened cement from instruments, but this can be time-consuming and may scratch the instruments. An ultra-sonic cleaner can clean hardened cement from instruments without scratching them.

Arranging Bagged Instruments Inside the Autoclave

Sterilized instruments should not be left overnight in the autoclave, but removed and allowed to dry overnight. Since the autoclave cycle can be time-consuming, it is best to only start the autoclave at a time during the workday when the assistant knows that the cycle will be finished before office closing time. Instruments in the autoclave can dry if, as soon as the cycle is over, the autoclave door

is opened slightly, to allow evaporation through the opening. However, bunched up instruments may not dry efficiently this way, and are best taken out of the autoclave, and perhaps temporarily stored on top of the autoclave paper side up to facilitate their drying. Avoid leaving the autoclave on with the door open. Some autoclaves may continue to heat while plugged in, causing all of the distilled water inside the chamber to evaporate, and eventually creating a burning or smoke smell in the office.

Instruments should be put paper side up and plastic side down in the autoclave, since pressurized air can enter the bag through the paper surface, which is not being blocked by being put on the floor of the chamber or shelf inside the autoclave (**Fig 4**). However, if the shelves inside the autoclave are perforated, the pressurized air may be able to pass through the shelf perforations and through the paper if the paper side is placed downward. If the autoclave has a built-in drying cycle, moisture can evaporate through the bags more efficiently if the bags are arranged paper side up in the autoclave, since if they are arranged plastic side up, the plastic will block the moisture from evaporating in an upward direction. After removing sterilized bagged instruments from the autoclave, they can be stored paper side up temporarily to allow the hot instruments to evaporate the moisture from the bags, or if dry they can be stored plastic-side up in their storage areas in the office, so that the contents of the bags are easily visible through the plastic.

Inside the autoclave, bagged instruments should be layered loosely on top of one another, to help facilitate flow of pressured air around and within the bags.[7] Heavier items should be put at the bottom of the autoclave, and lighter items above the heavier items. Autoclave shelves inside the autoclave should be used to reduce compacting of instruments (**Fig 4**). The hottest part of the autoclave is on the bottom, so it is advised to put more delicate items or plastic instruments at the top part of the autoclave.

Some sources advise standing up the pouches vertically in the autoclave, in a vertical rack, to facilitate adequate pressurized air circulation around the pouches, instead of laying the bags horizontally in the autoclave.[17] Either approach works if the sterilization indicator inside the bag changes color to indicate sterilization with either bag orientation. Pouches should ideally not contact the chamber walls, which could reduce circulation of pressurized air around the pouches. There may be hot spots on the chamber walls that can burn bags contacting the walls.

If a pouch falls into a crevice around or under a shelf inside the autoclave, it should immediately be retrieved. Otherwise, if left there, the bag may become forgotten, and become repeatedly autoclaved. Eventually the bag paper will burn and carbonize, creating a smoke smell in the office. The assistant should now and then check the inside of the autoclave for the charred remains of forgotten bags.

Common Errors When Bagging Instruments

The assistant should close the autoclave bag precisely. If it is imprecisely folded, an opening can exist between the inside contents and the outside. The assistant should not, for example, fold the bag in half when sealing the bag, or fold over the bag such as to stick the sticky part of the bag an inch or a few inches down the bag length. Here, the bag will be fully open, since the adhesive strip is completely stuck on the plastic surface of the bag, instead of joining and sealing both the plastic and the paper surfaces on either side of the opening of the autoclave bag. The self-adhesive strip of the autoclave bag must be folded exactly and completely along the fold line of the strip. This will guarantee that half of the adhesive strip will contact the paper surface on one side of the opening of the autoclave bag, and the other half of the adhesive strip will contact the plastic surface on the other side of the autoclave bag opening, resulting in a complete seal of the autoclave bag. Otherwise, an improper seal will create a

tiny opening at the end of the autoclave bag that may allow contaminants or dust to get inside the sterilized bag after it has been removed from the autoclave and placed in storage.[18]

In general, instruments should be placed in a sterilization pouch tip-side-down, such that the instrument tips or working ends are visible through the plastic, and not covered by the paper of the autoclave bag seal (**Fig. 9**). This is important with instruments that are bagged individually, such as oral surgery elevators and forceps, where the dentist will need specific sizes of instrument tips to perform specific tasks, and will not be able to quickly see the tips of instruments hidden under the autoclave paper.

Fig. 9: A correctly bagged oral surgery elevator (top), where the tip is fully visible. When incorrectly bagged (bottom), the tip is located at the bag opening and is covered by the adhesive paper that seals the opening.

Small instruments such as burs, endodontic files or turbo-piezo cavitron tips could become stuck to the adhesive of the autoclave bag if the assistant was closing the bag while holding the bag with the opening facing downwards, causing burs or tips to shift towards the bag opening while the assistant was closing the bag. The adhesive of the strip may then close over a bur or tip, trapping it inside the bag, such that the paper of the autoclave opening was covering the bur or tip, and making it difficult to see the tip or bur. Burs or tips can also become trapped under the paper at the opening of the autoclave bag if the assistant incompletely folded the adhesive strip of the bag, creating a tiny opening at the opening of the bag that a bur or tip could move into, and possibly become stuck to any exposed adhesive strip in the area. The dentist may not be able to dislodge the tip from the adhesive to see what the actual tip shape is.

If a sterilized autoclave bag becomes torn, the bag is technically not sterile and the bag contents should be placed in a new bag and re-sterilized. Sometimes, a sharp instrument, such as an endodontic explorer, pair of scissors, periodontal explorer or a scalpel may poke out through an autoclave bag. This may occur if the sharp instrument is bagged with other instruments in the same bag, such that when the bag is moved, the other instruments shift such as to push the sharp instrument with force into the bag. To prevent this, the sharp instrument may be bagged separately in its own bag. Also, the paper of some brands of autoclave bags may be thin and weak, and be prone to easy perforation with a sharp instrument. If a brand of autoclave bag is weak or is of otherwise poor quality, it may be dangerous to use such a bag in a dental clinic, and instead a stronger, and perhaps more expensive, higher value autoclave bag should be purchased by the office. A bag of autoclaved instruments, if intact and stored at room temperature in a dust-free drawer, should maintain the sterility of the autoclaved instruments for a long time period, which in one study was found to be at least 124 days.[19]

Conclusion

The sterilization of dental instruments between patients is essential to prevent disease transmission among patients of a dental office. Proper sterilization depends on removing gross debris from instruments prior to sterilization, not mixing bags of unsterilized instruments with bags of sterilized instruments, and having a functioning, properly maintained, and continually tested steam autoclave device.

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